

MONTHLY WEATHER REVIEW

Editor, W. J. HUMPHREYS

VOL. 61, No. 6
W. B. No. 1106

JUNE 1933

CLOSED AUGUST 3, 1933
ISSUED SEPTEMBER 22, 1933

FLOODS OF MARCH TO JUNE 1933 IN THE UNITED STATES

By RICHMOND T. ZOCH

[Weather Bureau, Washington, July 1933]

Each spring and early summer some of the rivers of the United States overflow their banks. In some years these overflows are infrequent and relatively unimportant, while in others they are frequent and attract considerable attention. The year of 1933 has been of the latter type.

Interest in floods has increased in recent years because of many extensive flood-protection projects. This article points out the most significant features of the floods of March, April, May, and June of 1933.

ST. LAWRENCE DRAINAGE

Minor floods occurred in the rivers of Michigan in March, April, and May, moderate floods in the Sandusky River in March, and in the Maumee River in May.

ATLANTIC SLOPE DRAINAGE

There were minor floods in the rivers of the South Atlantic Slope in all 4 months, and in the rivers of the Middle Atlantic Slope in April. Moderate floods occurred in the Connecticut River and in the James River in April.

EAST GULF OF MEXICO DRAINAGE

There were minor floods in nearly all of the rivers of this section in March and April. In April there also was a moderate flood in the Pearl River, and in May a moderate flood in both the West Pearl and Bogue Chitto Rivers.

MISSISSIPPI SYSTEM

Upper Mississippi Basin

Heavy rains in the upper Mississippi Basin which began on March 28, became unusually heavy on March 31 and April 1, and, in some sections, continued until the middle of May, caused floods in many of the tributaries of the Mississippi River. They caused two crests in the Illinois River and three in the Mississippi.

In southern Wisconsin and northern Iowa deep snows were melting somewhat rapidly when these rains began, and the combined rain and melting snow caused some very rapid rises, especially in the small streams.

The first crest in the Illinois River was the highest flood in the upper part since 1927 and the highest in the lower part since 1929. Before the river had fallen below the flood stage at all points a second and greater rise began. The crest of this second rise was only moderately high at Morris, lower in fact than the earlier crest. At Peru the crest was equal to the highest gage reading of record, but was 3.2 feet lower than the high watermark of June 1916. At Henry it was the highest of record. At Peoria it was the highest actual gage reading of record, but was 0.87 foot lower than the high watermark of June

1844. At Havana and Beardstown the crests were the second highest, being exceeded only by the crests of October 1926. At Pearl the crest was not so high as on several other occasions, probably owing to comparatively low water in the Mississippi at the mouth of the Illinois, and to breaks in levees above Pearl.

Although the stages were extremely high in the Illinois River, flood losses were not so large as might have been expected. The river rose so slowly that movable property could be taken care of. At Beardstown flood protection works have been built to protect the city from floods up to 27.75 feet on the gage.

The three crests in the Mississippi River were not of much significance.

Missouri Basin

Only three minor floods occurred in the Missouri Basin during these 4 months. The fact that the Missouri River was comparatively low lessened the severeness of the floods in the lower Mississippi.

Ohio Basin

In no southern tributary of the Ohio, except the Monongahela, was there more than a minor flood from March to June. However, nearly all of these tributaries were close to bankful stages for considerable periods.

Important floods occurred in every northern tributary of the Ohio River in March. Except for the Wabash System, only minor floods occurred in these tributaries in April and May.

In the Wabash System stages were comparatively low at the beginning of March. Heavy rainfall began in parts of this basin on March 9, and from then until April 19 was repeated at rather frequent intervals. The soil became saturated, and the run-off thereafter was comparatively high, although the rate of run-off seemingly varied considerably owing to irregular distribution of rainfall. River stages at all stations were somewhat low at the beginning of May due to the comparatively dry weather of the last 10 days of April. In May, however, rains occurred frequently with occasional to numerous, but rather irregularly distributed, excessive falls.

The five greatest general floods of recent years in the Wabash-White Valley were those of March 1913, February 1916, April 1922, January 1930, and May 1933. As a rule that of May 1933 stands fourth in order of severity in the White River Valley, although at Anderson, Ind., it was second, and at Noblesville, Ind., third. In the Wabash River Valley, however, there was more variation. At Bluffton, Ind., it was fifth; at La Fayette, Ind., fourth; at Terre Haute, Ind., second; at Mount Carmel,

Ill., fourth; while at Logansport, Ind., the flood stage was not reached.

This irregularity in order was no doubt owing to the very irregular distribution of the rainfall, both as to amount and time. However, this irregularity is not hard to account for since the May 1933 flood occurred later in the year than any of the other floods mentioned above.

In the Ohio River three crests occurred. The first extended from Pittsburgh, Pa., to Cairo, Ill., from March 15 to April 4. The second from Dam No. 47 to Cairo, from April 22 to April 24. The third from Portsmouth, Ohio, to Cairo, Ill., from May 14 to May 24. The second of these crests was the least important and the rise it caused was not even noticed in the lower Mississippi River below New Madrid, Mo.

The flood of March was more severe than any since the very disastrous one of 1913. Table 1 shows how this flood compares with others since 1913 for the Ohio River. In it are given, for a few selected points, all the crest stages from 1913 to 1933 that were higher than the crest stages of the March 1933 flood.

TABLE 1.—Stages higher than March 1933 since 1913

Station	Crests	Year	Remarks
Pittsburgh, Pa.	31.6	1915	
	30.3	1918	
	32.4	1924	
	29.7	January 1927	
	30.4	December 1927	
St. Marys, W. Va.	39.7	1915	
Marietta, Ohio	41.7	January 1927	
Parkersburg, W. Va.	44.0	1927	
Point Pleasant, W. Va.	45.5	1927	
Cincinnati, Ohio			Highest since 1913.
Louisville, Ky.			Do.
Evansville, Ind.			Do.
Shawneetown, Ill.			Do.
Paducah, Ky.	48.9	1922	

The significant feature of this flood was the suddenness with which it took place. On March 12, 1933, fair weather prevailed over the Ohio Valley, and while a low was centered over Alberta, no especially heavy rains were indicated for the Ohio Valley. The river was at about average stage for this season of the year. Table 2 shows the stages of the river at selected points at 8 a.m. on March 13, 1933.

TABLE 2.—River stages at large cities on Ohio River on Mar. 13, 1933

Station	Stage	Remarks
Pittsburgh, Pa.	12.8	
Parkersburg, W. Va.	12.4	
Huntington, W. Va.	17.3	
Portsmouth, Ohio	20.3	
Cincinnati, Ohio	22.3	
Louisville, Ky.:		
Upper gage.	17.0	Pool stage.
Low-water gage.	16.8	Do.
Owensboro, Ky.	13.9	Lowest for month.
Evansville, Ind.	16.2	Do.
Paducah, Ky.	18.6	
Cairo, Ill.	26.2	

Not only was the river at practically an average stage, but also the ground was not overly moist for this season. Precipitation was above normal over all of the Ohio Valley, except the extreme eastern part, in December 1932. In January 1933 precipitation was below normal for all of the Ohio Valley except eastern Kentucky. For February 1933 precipitation was below normal over all of the Ohio Valley except the Cumberland and Tennessee Basins. For the entire winter (December–February) precipitation was below normal in the mountainous east-

ern section and about normal in the remainder of the basin. There was no snow on the ground when rain began on the night of March 12–13.

The low which was centered over Alberta on the morning of March 12 had moved to western Iowa on the morning of March 13, and had caused rains to set in over the Ohio Valley during the night of March 12–13. At 8 p.m. of March 13 this low was centered just south of the southern end of Lake Michigan. On the morning of March 14 it had moved to central Michigan and had developed a secondary. This low and its secondary then moved northeastward until the evening of March 15 when they had merged and were centered over eastern Maine. Rains over the Ohio Valley ceased during the day of March 15. The total precipitation caused by this storm is shown in chart I. It should be observed that the heaviest rain fell in the vicinity of Pittsburgh.

Generally fair weather prevailed on the 16th and 17th. On the morning of the 17th a low was centered over Colorado which moved slowly east-southeastward and caused rains to set in over the Ohio Valley during the night of March 17–18. On the evening of the 19th this low was centered over western Kentucky, whence it moved slowly north-northeastward. At most places in the Ohio Valley rains ceased on the 21st. The precipitation caused by this storm is shown in chart II. It should be noticed that the heaviest rain fell around Cincinnati just in time for the run-off from the region of heaviest rainfall to reinforce the crest coming from Pittsburgh. Chart III shows the total precipitation caused by both storms.

While the great flood of 1913 occurred at almost the same time of the year as this flood, the storms which caused the precipitation show no similarity. In 1913 the heavy rains were caused by a storm which developed a trough of low pressure. This trough of low pressure moved very slowly, and rain continued for nearly 5 days. No other heavy rains occurred until the flood waters subsided.

Although the flood of 1933 was, in general, the highest in the Ohio Valley since 1913, and in spite of the fact that it came on with great suddenness, it was not a very disastrous flood. A detailed statement of damage caused will be published at the end of this year. The total damage approximates \$2,000,000. This low figure is the combined result of flood protection works and the promptness with which the Weather Bureau issued, and the general public heeded, flood warnings.

The following excerpts of reports from officials in charge are of much interest.

Pittsburgh, Pa.—Heavy rainfall over the Pittsburgh district on March 13, with locally heavy downpours in the Monongahela Basin, during the afternoon and night of the 13th, caused rising rivers throughout the district, with a notably rapid rise in the Monongahela River and its tributaries. At Lock No. 7, Greensboro, Pa., the Monongahela River rose 21.0 feet in the 24 hours ending at 8 a.m. of the 14th, and at Pittsburgh, the Monongahela and Ohio Rivers rose at an average rate of 1 foot an hour from 5 a.m. to 1 p.m. of the 14th.

This amazingly rapid rise and the resulting swift current in the Monongahela side of the Pittsburgh Harbor was the cause of by far the greater portion of the damage sustained, as a result of the flood in the Pittsburgh district. Fleets of loaded coal and sand barges, towboats, and dredge boats broke away from their moorings at Pittsburgh. Many of them were either beached or sunk in the channel by the swift current.

Cincinnati, Ohio.—On the morning of March 13, 1933, the Ohio River in the Cincinnati district was at a nearly normal stage. The stage at Cincinnati at 8 a.m. was 22.3 feet and the average during the last 20 years has been 25 feet. In the upper portion the river stages were as low as 7.8 feet at Dam No. 12 near Wheeling, W. Va.

Quite general rains started throughout the Ohio Valley on the morning of the 13th and continued during the 14th and ended at most places in the early morning of the 15th. These rains were

Chart I. Precipitation in Ohio Valley, March 13-16, 1933

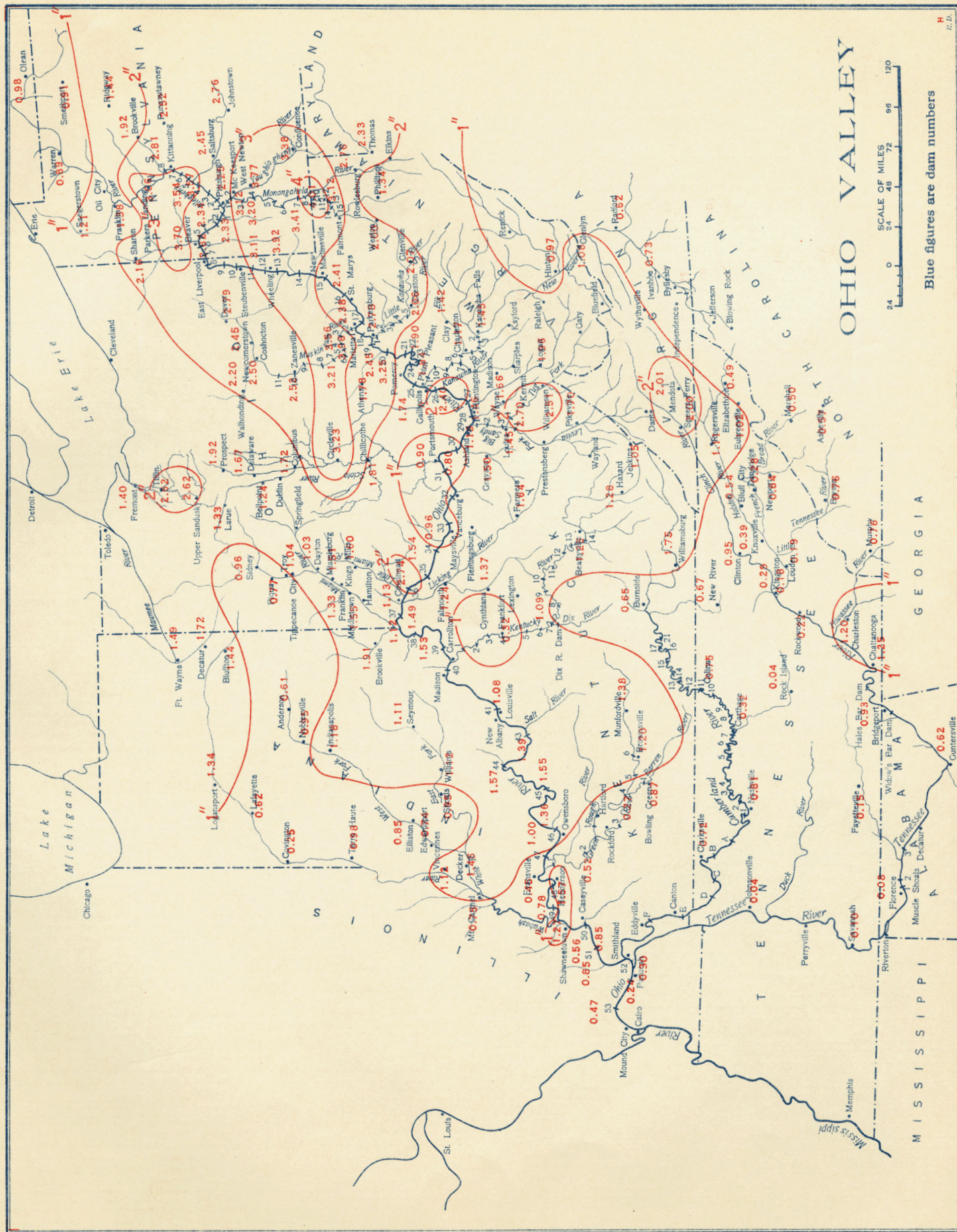


Chart II. Precipitation in Ohio Valley, March 17-20, 1933

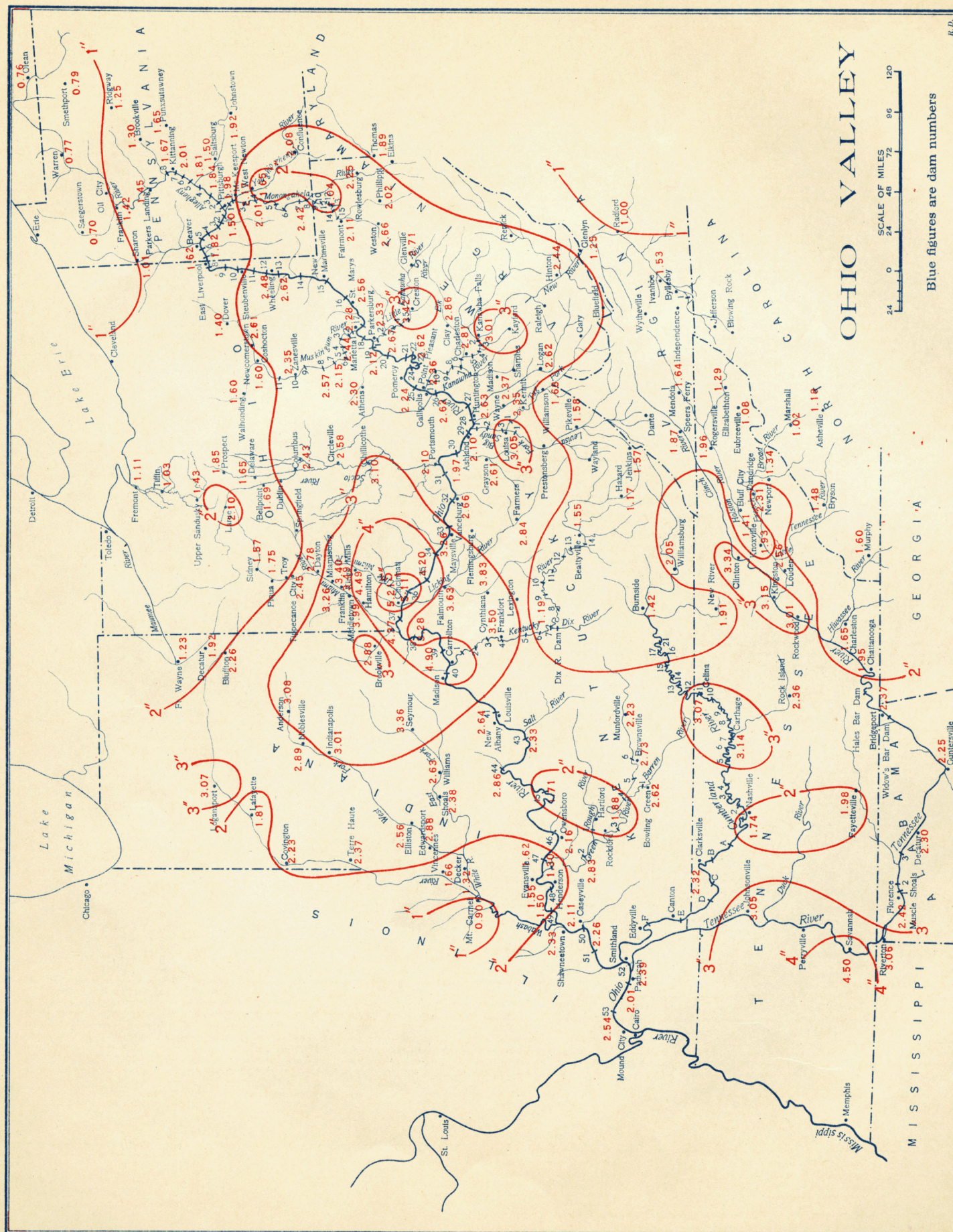
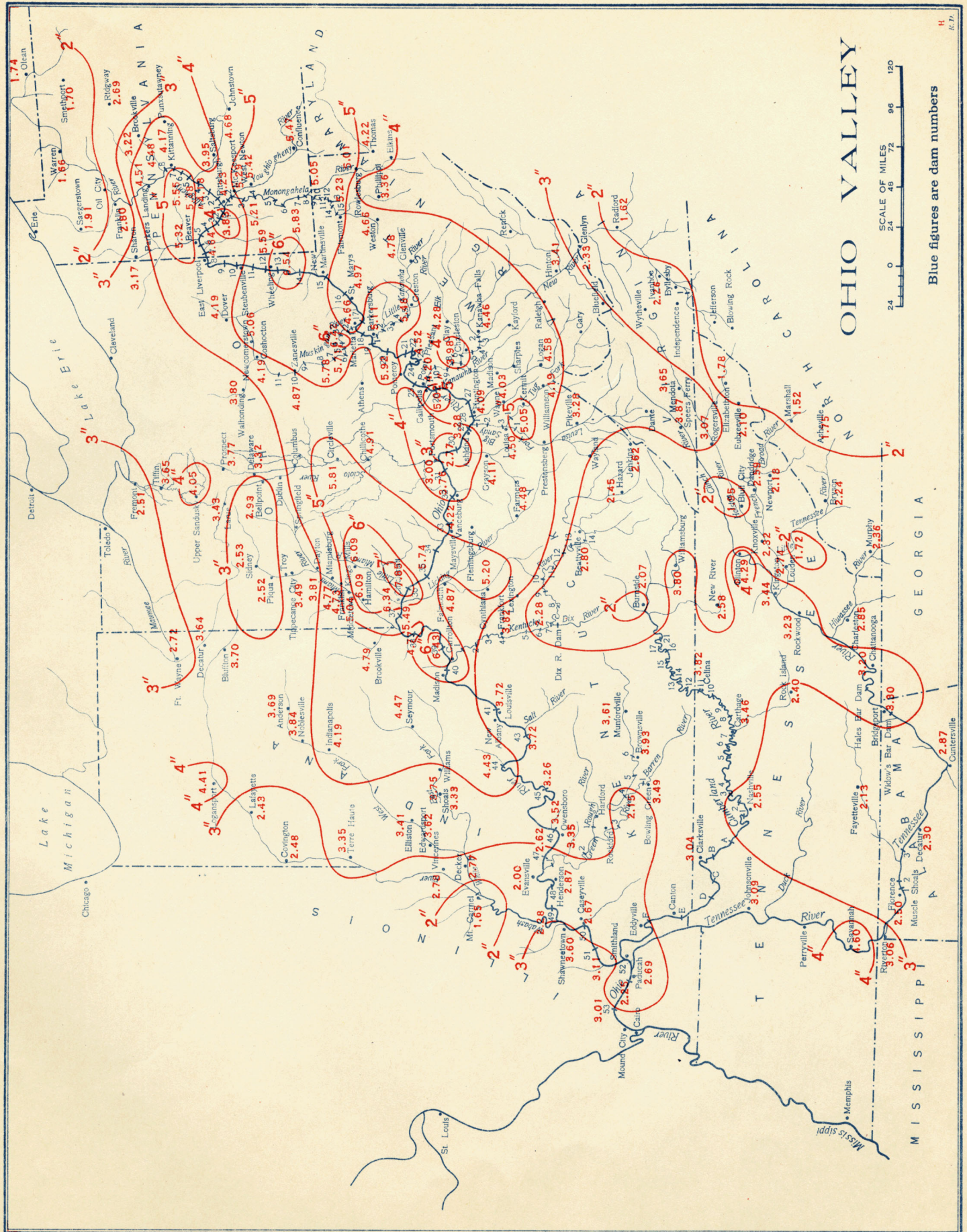


Chart III. Precipitation in Ohio Valley, March 13-20, 1933



not unusually heavy over the middle portion of the Ohio Valley, the average amounts being less than 1½ inches, but were moderately heavy over the upper portion of the valley, the amount being over 3 inches at a few stations.

As a result of these rains the Ohio River rose quite rapidly and passed the flood stage in the Pittsburgh district. The crest of the rise from the headwaters reached the Cincinnati district at the mouth of the Kanawha on the morning of March 18. This water was not quite sufficient to fill the river in the extreme upper portion of this district as the stages at both Dams 27 and 28 were from 3 to 4 feet below flood stage, but with the addition of some water out of the Big Sandy, the stage at Dam No. 29, Ashland, Ky., reached and passed flood stage by 6 inches. Without the addition of more water the crest stage would have been very near flood stage from Dam 29 to Dam 39.

None of the tributaries which enter the Ohio River in the Cincinnati district were in flood during the first storm, although both the Big Sandy and the Licking ran out fairly strong. The Kanawha-New River continued low and there was very little rise in the Big Miami.

The weather map on the morning of March 18 showed a well-defined depression central over Kansas and extending eastward across the Ohio Valley. This type of map was favorable for general rains in the Ohio Valley, but the indications were not for heavy or excessive rains. However, the rains did come both heavy and excessive and with greatest intensity in the immediate vicinity of Cincinnati. The greatest rainfall in 36 hours was nearly 5 inches, and the rainfall was at the rate of 1 inch per hour for a considerable time. These excessive rains extended about 100 miles both up and down the river from Cincinnati and some 50 miles southward into Kentucky, and northeastward in the Little Miami Valley. Some portions of the Kanawha Valley in West Virginia received 3 inches or more, but as a rule the rainfall was not unusually heavy from Portsmouth up to the mouth of the Kanawha. The precipitation in this last storm was comparatively light over the headwaters of the Kentucky tributaries and also those of the Ohio which enter the Ohio River in the Cincinnati district.

These last excessive rains caused an unusually rapid rise in the Ohio at Cincinnati. The river reached and passed flood stage at 10 p.m. March 18 and finally reached the crest stage of 63.6 feet at 5 p.m. March 21. It rose 11.1 feet in 24 hours from March 18 to March 19, an unusually rapid rise when the river is above the flood stage.

Louisville, Ky.—The unusually rapid rise of March 19 and 20 caused much apprehension even on the part of those affected only by the highest floods. As the flood developed many rumors and unauthorized reports became current, resulting in much labor in denying and correcting them. This was due partly to the relatively long period of comparative security enjoyed by the dwellers on the low sections; for the present flood was the highest since 1913 and the first of major proportions since January 1927. The usual uneasiness in regard to the river had become allayed during the long period of deficient precipitation. When aroused by the sharp rise on a river almost at flood stage, the people were ready to credit the wildest rumors.

Very heavy rains fell over Southern Ohio and Northern Kentucky on May 13 and 14. At this time Cincinnati, Ohio, received its greatest 24-hour rainfall of record, viz, 5.50 inches. This narrow strip of heavy rainfall caused the Ohio to reach the flood stage immediately thereafter, although several of the tributaries did not reach the flood stage. While this flood was considerably lower than that of March 1933 it is noteworthy because the crest stage at Cincinnati, 54.1, was the highest on record between May 1 and December 1, except for the August flood in 1875, when the crest stage was 55.4 feet.

White Basin

A severe flood occurred in the Black River in April and another one in May. These two floods were exceeded only by the August 1915 and April 1927 floods. A moderate flood occurred in the White River in May.

Arkansas Basin

There were minor floods in the lower Arkansas River in March and April, and in the Petit Jean River in April. In addition, heavy rains in Kansas and Oklahoma from May 12 to May 15 caused overflows in all of

the smaller streams, and slight floods in the Verdigris, Neosho, Canadian, and Arkansas Rivers.

Red Basin

The Red River had no flood, but several overflows occurred in the Sulphur, a tributary of the Red.

The absence of appreciable floods in the Missouri, Arkansas, and Red Basins lessened the criticalness of floods in the lower Mississippi. If the Ohio and upper Mississippi floods had been reinforced by large floods in the Missouri, Arkansas, and Red Rivers there would have been a major flood in the lower Mississippi.

Lower Mississippi Basin

Severe floods occurred in the St. Francis River in both April and May. That of April caused 4 breaks in the levees, while that of May caused 19 breaks. The crest stage in May at Chaonia, Mo., was within 1.5 feet of the highest water of record. At Fisk, Mo., and St. Francis, Ark., the crests of May were the highest stages of record. Considerably higher water would have occurred at the lower stations on this river if there had been no breaks in the levees.

The flood in the Tallahatchie-Yazoo Rivers lasted for 6 months and reached high stages. The crest at Swan Lake, Miss., was exceeded only by the flood of 1932. The crest at Greenwood, Miss., was exceeded by the floods of 1882, 1927, and 1932. There were no rises of importance in the Ouachita River.

There were two distinct rises in the lower Mississippi River. The first lasted from March 26 to about the middle of May, and was principally the result of the first rise in the Ohio River. The second lasted from the middle of May to June 19 and was principally the result of the third rise in the Ohio River and the nearly simultaneous overflows in the upper Mississippi River. The lower Mississippi River did not pass below the flood stage at all points between these two rises.

Both of these overflows were considerably lower than the flood of 1929. (See "The Flood of 1929 in the Lower Mississippi Valley", p. 317, vol. 57, M. R. W., 1929.) However, they caused considerable damage, the total reported for the entire lower Mississippi Basin being \$6,893,253.

Although crevasses occurred in the levees of the St. Francis and Tallahatchie-Yazoo Rivers, there were none in the levees of the lower Mississippi River. Furthermore, it is of interest to note that below Helena, Ark., the second rise was larger than the first, while above this place, the first rise was larger than the second. This was due to the fact that the Arkansas River was considerably higher during the second rise than it was during the first rise.

Atchafalaya Basin

From the point of view of damage caused, the flood in the Atchafalaya River was of minor consequence. However, the river reached the second highest stage since the great flood of 1927 at the Atchafalaya, La., gage. In fact, the 1932 stage at this gage exceeded the 1927 stage, and since this significant occurrence was not commented upon in the MONTHLY WEATHER REVIEW during 1932, a few comments will be proper here. The official in charge of the New Orleans, La., Weather Bureau office writes as follows:

The recent changes in the Atchafalaya River, especially since the extension of levees along a considerable part of the river, are very interesting. Aside from the fact that a considerable part of the

Atchafalaya Basin flow in 1927 was outside the broken-down levees, it is a fact that deposits below Atchafalaya, La., have resulted in higher stages than formerly at that point, and more back-water in the open area between the levees that are near the river and the levees that are placed back several miles from the river.

When the Atchafalaya is high, the natural slope in the middle portion is considerably steeper than in the extreme upper portion or the lower portion. This condition, after the levees were constructed, has enabled the river to scour its channel very effectively even to a point not less than 6 miles below Atchafalaya, the scour thus extending slightly farther south than the levees near the river. The extent of this channel erosion is indicated by the following table, from "The Improvement of the Lower Mississippi River for Flood Control and Navigation", volume I, page 53 (prepared under the direction of the president of the Mississippi River Commission, by D. O. Elliot, major, Corps of Engineers):

Comparative channel areas—Below bankful stage

[Barbre Landing (0 mile) to Butte La Rose (66.9 miles)]

Reach	Miles below Barbre Landing	Surveys				
		1880-81	1904-5	1916-17	1927	1931
A-----	0-13.7	Square feet 53,200	Square feet 55,600	Square feet 62,200	Square feet 77,200	Square feet 65,400
B-----	13.7-29.8	40,700	55,900	63,200	77,600	71,600
C-----	29.8-36.9	32,200	50,700	56,300	64,100	59,000
D-----	36.9-43.0	22,100	32,300	40,200	56,600	55,100
E-----	43.0-52.0	-----	18,900	40,000	65,400	59,700
F-----	52.0-63.7	-----	14,000	21,600	33,200	34,600
G-----	63.7-66.9	-----	14,000	16,700	17,300	22,900

Simmesport is 5 miles below the head of the river at Barbre Landing, Melville 31 miles below, and Atchafalaya 61.6.

Comments on the above table appear in the publication above referred to, as follows:

"Table V indicates the extent to which channel enlargement has followed the extension of the Atchafalaya River levees. It will be noted that the channel enlargement reached its maximum in 1927 and that since that date there has been an appreciable deterioration in average channel cross section from Reach A to Reach E, inclusive. Reaches F and G have enlarged since 1927. This observed channel deterioration is readily explained by the fact that the year 1927 was an abnormal flood year, which has until the present (December 31, 1931) been followed by only one flood (1929). The flood of 1927 caused a greater channel enlargement than the river could subsequently maintain. Deterioration was therefore inevitable. The fact that the channel through Reaches F and G has continued to enlarge since 1927 is explained by the fact that these reaches are generally unleveed. The effect of the 1927 flood on the channel through these reaches was therefore much less pronounced than in the leveed reaches above."

The following in reference to silting in the lower Atchafalaya Basin is quoted from page 56 of the same publication:

"Below the lower limit of Atchafalaya Levee influence silting is taking place in the Atchafalaya Basin. This silting is probably more extensive now than it was before the channel enlargement permitted a marked increase in the volume of the Atchafalaya discharge. The Atchafalaya presents an interesting study in the development of an alluvial stream. The river is now silting up the existing Mississippi River Delta which it must cross before it can push its own channel to the sea and undertake the construction of its own delta. At present the flow of the Atchafalaya is dissipated in a network of inefficient channels in the lower portion of the basin. When, however, this sedimentation has raised the surface of the basin to a sufficient elevation, the river will be forced to develop an efficient channel and push it to the sea."

The effect of the changes that have taken place on stages at Atchafalaya as related to Melville stages is shown by the following table, giving highest stages from 1927 to 1933:

Station	1927	1928	1929	1930	1931	1932	1933
Simmesport-----	53.4	37.8	46.4	35.8	29.8	47.7	41.2
Melville-----	46.8	37.6	42.2	35.0	30.5	42.8	38.3
Atchafalaya-----	24.6	21.6	22.6	22.3	22.4	24.9	24.1
Difference Melville-Atchafalaya-----	22.2	16.0	19.6	12.7	8.1	17.9	14.2

We may compare stages in 1932 with those in 1929 with Melville 1932 higher than 1929 by 0.6 foot and the difference between Melville and Atchafalaya 1.7 feet less than in 1929. Or we may compare 1933 with 1928, with Melville 0.7 foot higher than in 1928, and the difference between Melville and Atchafalaya 1.8 feet less than in 1928.

The progressive character of the changes that are taking place may be noted by comparing the stage at Melville with the stage at Atchafalaya when the stage of 22 feet is reached at Atchafalaya in successive years. After the stage of 22 feet is passed at Atchafalaya the increase in overflow makes the rate of further rise slow. But the southward escape of the water is so retarded by the silting referred to that stages at Atchafalaya increase progressively in relation to stages at Melville.

WEST GULF OF MEXICO DRAINAGE

Several minor overflows occurred in the Trinity River in Texas. There was also a minor overflow in the headwaters of the Rio Grande.

GULF OF CALIFORNIA DRAINAGE

There was a flood of small importance in the Colorado River and some of its tributaries in May and June.

GENERAL REMARKS

All the floods mentioned above were forecast by the Weather Bureau in advance, and considerable property was saved. In the Mississippi system \$6,604,782 worth of property was saved as a result of flood warnings during the 4 months under discussion. Outside of the Mississippi system \$454,202 worth of property was saved.

Four persons were drowned by the flood waters of rivers of the upper Mississippi Basin, and one by the flood of the Scioto, a tributary of the Ohio.

Below is a table showing the crests reached and the time the water was above flood stage for all of the Weather Bureau gages where floods occurred in these 4 months.

Table of flood stages March to June, inclusive, 1933

River and station	Flood stage	Above flood stages—dates		Crest	
		From—	To—	Stage	Date
ST. LAWRENCE DRAINAGE					
Red Cedar:	Feet			Feet	
Williamston, Mich.....	6	Apr. 2	Apr. 3	7.5	Apr. 2.
East Lansing, Mich.....	8	do.	do.	9.1	Do.
Grand:					
Eaton Rapids, Mich.....	5	Apr. 3	Apr. 4	5.0	Apr. 3-4.
Grand Ledge, Mich.....	7	Mar. 16	Mar. 16	7.0	Mar. 16.
		Apr. 3	Apr. 3	7.0	Apr. 3.
Flint: Columbiaville, Mich.....	8	Apr. 2	Apr. 6	9.8	Do.
		Apr. 20	Apr. 21	8.4	Apr. 20.
Pine: Alma, Mich.....	6	May 2	May 2	6.9	May 2.
Chippewa: Mount Pleasant, Mich.....	12	May 3	May 3	12.1	May 3.
Tittabawassee:					
Midland, Mich.....	18	Apr. 19	Apr. 19	18.6	Apr. 19.
		May 3	May 3	20.5	May 3.
Shields, Mich.....	10	do.	May 7	15.5	May 3-4.
St. Joseph: Fort Wayne, Ind.....	12	Mar. 15	Mar. 15	12.1	Mar. 15.
		May 9	May 12	13.3	May 12.
Maumee: Fort Wayne, Ind.....	15	do.	May 14	17.3	Do.
Sandusky:					
Upper Sandusky, Ohio.....	13	Mar. 14	Mar. 15	14.8	Mar. 14.
Tiffin, Ohio.....	7	do.	Mar. 14	7.1	Do.
Fremont, Ohio.....	11	Mar. 15	Mar. 15	12.8	Mar. 15.
ATLANTIC SLOPE DRAINAGE					
Connecticut:					
Woodsville, N.H.....	12	Apr. 18	Apr. 21	15.4	Apr. 19.
White River Junction, Vt.....	18	do.	Apr. 23	24.3	Do.
Holyoke, Mass.....	10	do.	do.	12.4	Apr. 20.
Springfield, Mass.....	20	Apr. 20	Apr. 20	20.0	Do.
Hartford, Conn.....	16	Apr. 8	Apr. 26	26.0	Apr. 21.
Schuylkill: Reading, Pa.....	10	Apr. 17	Apr. 18	11.0	Apr. 17.
North Branch: Cumberland, Md.....	17	Mar. 14	Mar. 14	17.9	Mar. 14.
Potomac: Sycamore Island, Md.....	10	Apr. 22	Apr. 22	12.0	Apr. 22.

Table of flood stages March to June, inclusive, 1933—Continued

Table of flood stages March to June, inclusive, 1933—Continued

River and station	Flood stage	Above flood stages—dates		Crest	
		From—	To—	Stage	Date
ATLANTIC SLOPE DRAINAGE—contd.					
James:	<i>Feet</i>			<i>Feet</i>	
Columbia, Va.-----	15	{Mar. 21 Apr. 17	{Mar. 22 Apr. 21	18.5 25.8	Mar. 21. Apr. 18.
Richmond, Va.-----	8	{Mar. 22 Apr. 18	{Mar. 22 Apr. 20	8.1 14.1	Mar. 22. Apr. 19.
Roanoke:					
Weldon, N.C.-----	31	{do-----	{Apr. 19	32.0	Apr. 18.
Williamston, N.C.-----	10	{Mar. 26 Apr. 21	{Mar. 29 May 2	10.3 10.9	Mar. 27-28. Apr. 26.
Neuse: Smithfield, N.C.-----	14	{Apr. 18	{Apr. 21	16.5	Apr. 19.
Santee:					
		{Feb. 9 Mar. 11	{Mar. 3 Mar. 12	15.2 12.2	Feb. 24. Mar. 12.
Rimini, S.C.-----	12	{Mar. 22 June 4	{Mar. 27 June 4	13.8 12.0	Mar. 25. June 4.
		{June 17	{June 17	12.0	June 17.
Ferguson, S.C.-----	12	{Feb. 9 Mar. 24	{Mar. 6 Mar. 30	13.7 12.8	Feb. 24-27. Mar. 27.
		{Feb. 9 Mar. 10	{Mar. 4 Mar. 12	19.5 14.8	Feb. 23. Mar. 10.
Savannah: Ellenton, S.C.-----	14	{Mar. 22 Apr. 19	{Mar. 26 Apr. 22	15.7 15.3	Mar. 23-24. Apr. 20.
		{May 10 June 27	{May 11 June 28	14.3 14.5	May 11. June 28.
Ogeechee:					
Dover, Ga.-----	7	{Feb. 8	{Mar. 5	8.1	Feb. 22-24.
Meldrim, Ga.-----	9	{Feb. 9	{Mar. 10	10.6	Feb. 26-28.
Ocmulgee: Abbeville, Ga.-----	11	{Feb. 23	{Mar. 2	13.4	Feb. 27.
Altamaha:					
Charlotte, Ga.-----	12	{Jan. 28 Mar. 23	{Mar. 8 Mar. 29	17.0 12.5	Mar. 2-3. Mar. 28.
Everett City, Ga.-----	10	{Feb. 11	{Mar. 11	10.8	Mar. 6-7.
EAST GULF OF MEXICO DRAINAGE					
Chattahoochee: Alaga, Ala.-----	30	{Mar. 21	{Mar. 23	33.2	Mar. 22.
Apalachicola:					
River Junction, Fla.-----	20	{Mar. 24	{Mar. 24	20.1	Mar. 24.
Blountstown, Fla.-----	15	{Jan. 28 Mar. 21	{Mar. 15 Apr. 25	20.4 21.0	Feb. 25. Mar. 25.
Choctawhatchee:					
Newton, Ala.-----	19	{Mar. 20	{Mar. 22	23.8	Mar. 21.
Geneva, Ala.-----	23	{Mar. 22	{Mar. 25	25.4	Mar. 22.
Caryville, Fla.-----	12	{do-----	{Mar. 27	13.7	Mar. 24.
		{Apr. 15	{Apr. 19	13.0	Apr. 16.
Conecuh: Brewton, Ala.-----	17	{Mar. 24	{Mar. 27	18.0	Mar. 26.
Coosa:					
Gadsden, Ala.-----	22	{Mar. 22	{Mar. 22	22.0	Mar. 22.
Lock No. 4, Lincoln, Ala.-----	17	{Mar. 21	{do-----	18.0	Mar. 21.
Cahaba: Centerville, Ala.-----	23	{Mar. 20	{Mar. 21	28.0	Mar. 20.
Alabama:					
Montgomery, Ala.-----	35	{Mar. 21	{Mar. 25	43.1	Mar. 23.
Selma, Ala.-----	35	{do-----	{Mar. 28	45.0	Mar. 24.
Millers Ferry, Ala.-----	35	{Feb. 21	{Mar. 1	42.4	Feb. 25-26.
		{Mar. 21	{Mar. 30	47.8	Mar. 26.
Black Warrior: Lock No. 10, Tuscaloosa, Ala.-----	46	{do-----	{Mar. 21	46.4	Mar. 21.
Tombigbee:					
Aberdeen, Miss.-----	34	{do-----	{Mar. 22	35.0	Do.
		{Apr. 3	{Apr. 3	34.5	Apr. 3.
Lock No. 4, Demopolis, Ala.-----	39	{Mar. 21 Apr. 15	{Apr. 4 Apr. 22	46.5 43.7	Mar. 26. Apr. 19.
Lock No. 3, Ala.-----	33	{Mar. 9 Mar. 20	{Mar. 13 Apr. 25	35.0 48.7	Mar. 11. Mar. 27.
Lock No. 2, Ala.-----	46	{Mar. 22 Apr. 15	{Apr. 4 Apr. 22	49.0 48.6	Apr. 2. Apr. 17.
Lock No. 1, Ala.-----	31	{Mar. 21	{Apr. 27	35.7	Apr. 2, 3, 18.
Pascagoula: Merrill, Miss.-----	18	{Apr. 15	{Apr. 25	19.6	Apr. 16.
Pearl:					
		{Feb. 8 Mar. 23	{Mar. 14 Apr. 1	25.0 22.4	Feb. 16-17. Mar. 28.
Jackson, Miss.-----	20	{Apr. 13 Mar. 2	{Apr. 19 Mar. 2	27.0 15.5	Apr. 21-22. Mar. 2.
Monticello, Miss.-----	15	{Apr. 1 Apr. 14	{Apr. 4 Apr. 29	20.2 21.7	Apr. 1. Apr. 21.
Columbia, Miss.-----	18	{Apr. 3 Apr. 15	{Apr. 5 Apr. 28	20.0 22.9	Apr. 4. Apr. 23.
		{do-----	{Apr. 17	12.6	Apr. 16.
Bogue Chitto: Franklinton, La.-----	10	{Apr. 20 May 2	{Apr. 23 May 4	12.0 17.0	Apr. 20. May 2.
West Pearl: Pearl River, La.-----	13	{Feb. 14 Apr. 1	{Mar. 25 May 12	15.4 16.7	Mar. 1. May 5.
MISSISSIPPI SYSTEM					
Upper Mississippi Basin					
Rock: Moline, Ill.-----	10	{Apr. 4 May 9	{Apr. 12 June 3	10.3 11.8	Apr. 9. May 30.
Cedar: Cedar Rapids, Iowa.-----	13	{Apr. 3	{Apr. 5	18.7	Apr. 4.
Iowa:					
Iowa City, Iowa.-----	8	{Apr. 9 May 24	{Apr. 13 May 28	10.0 8.8	Apr. 10. May 26.
Wapello, Iowa.-----	7	{Apr. 5 May 22	{Apr. 15 May 27	15.4 9.2	Apr. 7. May 24.
Des Moines:					
Boone, Iowa.-----	20	{Mar. 31	{Apr. 4	24.4	Apr. 2.
Tracy, Iowa.-----	14	{Apr. 5	{Apr. 8	16.6	Apr. 6.
Ottumwa, Iowa.-----	9	{Apr. 4	{Apr. 9	11.8	Apr. 8.

River and station	Flood stage	Above flood stages—dates		Crest	
		From—	To—	Stage	Date
MISSISSIPPI SYSTEM—continued					
Upper Mississippi Basin—Contd.					
Illinois:	Feet			Feet	
Morris, Ill.	13	{Apr. 1 May 9	{Apr. 7 May 18	19.2 18.3	Apr. 2. May 14.
Peru, Ill.	17	{Apr. 1 May 6	{Apr. 24 June 4	21.6 23.8	Apr. 3. May 15.
Henry, Ill.	10	{Mar. 30 Apr. 2	{June 10 Apr. 27	18.7 22.3	May 18. Apr. 8.
Peoria, Ill.	18	{May 6 Mar. 28	{June 7 June 17	25.4 23.1	May 18. May 23.
Havana, Ill.	14	{do do	{June 19 June 19	25.5 25.5	Do. Do.
Beardstown, Ill.	14	{do Apr. 1	{June 19 June 18	25.5 20.8	Do. May 29, 30.
Pearl, Ill.	12	{do May 14	{June 19 May 17	25.5 17.5	Do. May 26.
Bourbeuse: Union, Mo.	12				
Meramec:					
Steelville, Mo.	12	{Apr. 16 May 14	{Apr. 16 May 15	15.0 17.0	Apr. 16. May 14.
		{Apr. 17 May 14	{Apr. 19 May 18	17.0 22.9	Apr. 18. May 16.
Pacific, Mo.	11	{May 26 Apr. 17	{May 27 Apr. 19	13.0 21.5	May 26. Apr. 18.
Valley Park, Mo.	14	{May 14 May 26	{May 19 May 27	28.0 15.3	May 17. May 26.
Mississippi:					
Keokuk, Iowa.	12	{Apr. 7 May 26	{Apr. 13 May 29	14.5 13.7	Apr. 9, 10. May 26.
		{Apr. 8 May 14	{Apr. 13 May 14	16.1 14.5	Apr. 10. May 14.
Quincy, Ill.	14	{May 26 Apr. 8	{May 29 Apr. 17	15.6 15.9	May 27. Apr. 10.
Hannibal, Mo.	13	{May 13 May 26	{May 16 May 30	14.8 15.8	May 14. May 27.
		{Apr. 8 May 13	{Apr. 18 May 17	14.4 15.0	Apr. 11. May 15.
Louisiana, Mo.	12	{May 26 Apr. 12	{May 31 Apr. 14	15.2 18.5	May 28. Apr. 13.
Grafton, Ill.	18	{May 15 May 25	{May 19 June 2	20.4 20.7	May 17. May 30.
Alton, Ill.	21	{May 15 May 26	{May 19 June 1	23.4 23.2	May 16. May 30.
Chester, Ill.	27	{May 16 May 29	{May 20 June 1	28.9 27.6	May 18. May 31.
Cape Girardeau, Mo.	32	{May 16 May 28	{May 22 June 1	34.4 32.5	May 19. May 30, 31.
Missouri Basin					
Soloman: Beloit, Kans.	18	Apr. 22	Apr. 22	18.6	Apr. 22.
Grand: Chillicothe, Mo.	18	May 26	May 26	18.3	May 26.
Missouri: St. Charles, Mo.	25	May 14	May 14	25.1	May 14.
Ohio Basin					
Alleghany:					
Lock No. 5, Schenley, Pa.	24	Mar. 15	Mar. 16	29.0	Mar. 15.
Lock No. 4, Natrona, Pa.	24	do	do	26.6	Do.
Lock No. 3, Springdale, Pa.	27	do	do	27.4	Do.
Youghiogheny: Confluence, Pa.	10	Mar. 14	Mar. 14	12.0	Mar. 14.
Monongahela:					
Lock No. 7, Greensboro, Pa.	30	do	do	34.4	Do.
Lock No. 4, Pa.	31	do	do	32.3	Do.
McKeesport, Pa.	16	do	do	16.9	Do.
Beaver:					
Sharon, Pa.	9	do	Mar. 16	10.8	Mar. 15.
Beaver Falls, Pa.	11	{Mar. 15 Mar. 14	{Mar. 15 Mar. 16	11.7 12.3	Do. Do.
Walbonding: Walbonding, Ohio.	8	{Mar. 19 May 14	{Mar. 22 May 15	11.8 13.4	Mar. 21. May 14.
Tuscarawas:					
Dover, Ohio.	9	Mar. 16	Mar. 16	9.6	Mar. 16.
Newcomerstown, Ohio.	11	do	Mar. 18	13.6	Mar. 17.
Coshocton, Ohio.	8	{Mar. 15 May 14	{Mar. 24 May 16	14.2 12.7	Do. May 15.
Muskingum:					
Lock No. 10, Zaneville, Ohio.	25	Mar. 19	Mar. 20	26.5	Mar. 19.
		{Mar. 16 May 15	{Mar. 22 May 16	26.5 23.8	Do. May 15.
Lock No. 7, McConnelsville, Ohio.	22	{Mar. 19 Mar. 17	{Mar. 20 Mar. 21	28.0 28.2	Mar. 19. Mar. 20.
Lock No. 4, Beverly, Ohio.	25	{Mar. 15 Mar. 16	{Mar. 22 Mar. 18	34.6 19.5	Mar. 16. Mar. 15.
Lock No. 3, Lowell, Ohio.	25	{Mar. 15 May 14	{Mar. 21 May 16	19.1 20.0	Mar. 20. May 15.
Lock No. 1, Marietta, Ohio.	28	{Mar. 15 May 14	{Mar. 21 May 15	19.1 9.2	Mar. 20. Mar. 14.
Hocking: Athens, Ohio.	17	{May 15 Mar. 14	{May 16 Mar. 15	20.0 13.0	May 15. May 14.
Olentangy: Delaware, Ohio.	9	{Mar. 15 May 14	{Mar. 15 May 14	11.2 13.0	Mar. 15. May 14.
Scioto:					
La Rue, Ohio.	11	{Mar. 20 May 12	{Mar. 21 May 12	11.3 11.3	Mar. 20. May 12.
		{May 14 Mar. 21	{May 14 Mar. 21	12.5 10.7	May 14. Mar. 21.
Prospect, Ohio.	10	{May 13 May 14	{May 16 May 14	11.7 11.6	May 13. May 14.
Bellpoint, Ohio.	9	{Mar. 20 Apr. 13	{Mar. 22 Apr. 13	13.6 10.3	Mar. 20. Apr. 13.
Circleville, Ohio.	10	{Apr. 19 May 12	{Apr. 20 May 17	11.4 17.3	Apr. 20. May 15.
		{Mar. 21 May 13	{Mar. 23 May 17	19.2 22.8	Mar. 21. May 16.
Chillicothe, Ohio.	16	{Mar. 19 May 14	{Mar. 19 May 14	24.3 22.1	Mar. 19. May 14.
Little Miami: Kings Mills, Ohio.	17	{May 14 Mar. 19	{May 14 Mar. 19	22.1 28.5	May 14. Mar. 19.
Licking: Falmouth, Ohio.	28	{Mar. 19 May 12	{Mar. 19 May 14	28.5 17.0	May 13. May 19.
Pleasant Hill, Ohio.	13	{May 12 May 14	{May 14 May 14	17.0 17.0	May 13. May 19.

Table of flood stages March to June, inclusive, 1933—Continued

River and station	Flood stage	Above flood stages—dates		Crest	
		From—	To—	Stage	Date
MISSISSIPPI SYSTEM—continued					
Ohio Basin—Continued					
Miami:	Feet			Feet	
Sidney, Ohio.....	12	May 13	do.....	13.7	Do.
Franklin, Ohio.....	16	May 15	May 15	16.1	May 15.
Middletown, Ohio.....	15	Mar. 19	Mar. 20	15.0	Mar. 19, 20.
		May 14	May 15	17.4	May 15.
		Mar. 21	Mar. 22	23.2	Mar. 22.
Barren: Bowling Green, Ky.....	20	May 12	May 14	23.1	May 13.
Green:					
Lock No. 4, Woodbury, Ky.....	33	Mar. 21	Mar. 24	36.4	Mar. 22.
		May 13	May 15	35.6	May 14.
Lock No. 2, Rumsey, Ky.....	34	Mar. 22	Apr. 9	38.7	Mar. 26.
		May 16	May 20	35.7	May 18.
West Fork of White:					
Anderson, Ind.....	12	May 12	May 15	17.6	May 14.
Noblesville, Ind.....	14	Mar. 21	Mar. 21	14.6	Mar. 21.
		May 12	May 15	17.6	May 15.
		Mar. 19	Mar. 28	25.4	Mar. 23.
Elliston, Ind.....	19	Apr. 17	Apr. 22	23.1	Apr. 20.
		May 14	May 23	27.8	May 16.
		Mar. 10	Mar. 10	12.3	Mar. 10.
Edwardsport, Ind.....	12	Mar. 16	Apr. 26	19.2	Mar. 25.
		May 4	May 31	20.1	May 17.
East Fork of White:					
Seymour, Ind.....	10	Mar. 19	Mar. 23	13.5	Mar. 21.
		Apr. 18	Apr. 20	12.9	Apr. 18.
		May 14	May 17	13.7	May 15.
		Mar. 22	Mar. 27	15.9	Mar. 24.
Williams, Ind.....	10	Apr. 21	Apr. 23	12.7	Apr. 22.
		May 15	May 22	18.6	May 18.
		Mar. 22	Mar. 28	27.2	Mar. 25.
Shoals, Ind.....	20	Apr. 21	Apr. 25	23.6	Apr. 23.
		May 15	May 23	29.8	May 19.
		Mar. 22	Apr. 4	23.9	Mar. 27.
White: Decker, Ind.....	18	Apr. 20	Apr. 28	21.3	Apr. 25.
		May 15	May 28	26.0	May 20, 21.
Wabash:					
Bluffton, Ind.....	11	May 13	May 16	12.7	May 13.
Logansport, Ind.....	15	Mar. 21	Mar. 21	15.1	Mar. 21.
		Mar. 20	Mar. 29	21.5	Mar. 22.
La Fayette, Ind.....	13	Apr. 2	Apr. 3	13.8	Apr. 2-3.
		Apr. 18	Apr. 20	15.2	Apr. 19.
		May 10	May 19	22.8	May 13.
		Mar. 20	Mar. 31	25.0	Mar. 23.
		Apr. 3	Apr. 5	17.8	Apr. 4.
Covington, Ind.....	16	Apr. 8	Apr. 9	16.7	Apr. 9.
		Apr. 19	Apr. 22	18.6	Apr. 20-21.
		May 10	May 21	27.7	May 14.
		Mar. 20	Apr. 11	20.1	Mar. 25.
Terre Haute, Ind.....	14	Apr. 19	Apr. 24	15.1	Apr. 22.
		May 9	May 26	25.1	May 15.
Vincennes, Ind.....	14	Mar. 23	Apr. 11	18.8	Mar. 29.
		May 14	May 31	24.4	May 20.
		Mar. 20	Apr. 29	23.7	Mar. 29.
Mt. Carmel, Ill.....	16	May 7	June 2	26.1	May 20.
		Mar. 22	Mar. 29	54.7	Mar. 27.
Cumberland: Lock F, Eddyville, Ky.....	50	Apr. 1	Apr. 7	52.2	Apr. 3.
		May 15	May 19	52.4	May 18.
Pigeon: Newport, Tenn.....	6	May 10	May 10	8.4	May 10.
Elk: Fayetteville, Tenn.....	14	Mar. 19	Mar. 19	16.2	Mar. 19.
		May 8	May 13	21.5	May 11.
Ohio:					
Pittsburgh, Pa.....	25	Mar. 15	Mar. 16	29.6	Mar. 15.
Old Dam No. 2, Corapolis, Pa.....	26	do.....	do.....	27.9	Mar. 16.
Dam No. 6.....	30	Mar. 14	Mar. 17	37.8	Do.
Dam No. 12.....	36	Mar. 15	do.....	39.2	Do.
Dam No. 13.....	43	Mar. 16	do.....	45.0	Do.
St. Marys, W. Va.....	38	do.....	Mar. 18	39.6	Mar. 17.
Marietta, Ohio.....	33	Mar. 15	Mar. 23	41.0	Do.
Parkersburg, W. Va.....	36	do.....	do.....	42.4	Do.
Dam No. 19, Little Hocking, Ohio.....	39	Mar. 16	Mar. 22	43.1	Do.
Dam No. 22, Ravenswood, W. Va.....	42	do.....	Mar. 23	46.4	Mar. 18.
Dam No. 25.....	40	do.....	Mar. 25	51.5	Mar. 21-22.
Point Pleasant, W. Va.....	40	do.....	do.....	50.9	Mar. 22.
Dam No. 26.....	50	Mar. 19	Mar. 24	54.6	Do.
Dam No. 28, Huntington, W. Va.....	50	do.....	do.....	55.0	Do.
Dam No. 29, Ashland, Ky.....	50	Mar. 18	Mar. 25	59.6	Do.
Dam No. 30.....	52	Mar. 19	do.....	59.4	Do.
Portsmouth, Ohio.....	50	Mar. 18	Mar. 26	60.7	Do.
Dam No. 32.....	53	May 17	May 17	50.2	May 17.
		Mar. 20	Mar. 25	58.4	Mar. 22.
Dam No. 33.....	48	Mar. 18	Mar. 27	58.7	Mar. 22-23.
		May 17	May 17	48.4	May 17.
Dam No. 35, New Richmond, Ohio.....	45	Mar. 18	Mar. 27	56.5	Mar. 22.
		May 15	May 18	45.9	May 17-18.
Dam No. 36.....	50	Mar. 18	Mar. 27	61.6	Mar. 21.
		May 14	May 18	51.3	May 14.
Cincinnati, Ohio.....	52	Mar. 18	Mar. 27	63.6	Mar. 21-22.
		May 14	May 18	54.1	May 15.
Dam No. 37.....	54	Mar. 19	Mar. 28	59.3	Mar. 22.
		do.....	do.....	58.0	Do.
Dam No. 38.....	45	May 14	May 20	50.2	May 15.
		Mar. 19	Mar. 28	53.6	Mar. 23.
Dam No. 39, Marland, Ind.....	45	May 15	May 18	46.2	May 16.
		Mar. 19	Mar. 28	54.5	Mar. 23.
Madison, Ind.....	46	May 15	May 16	46.7	May 16.

Table of flood stages March to June, inclusive, 1933—Continued

River and station	Flood stage	Above flood stages—dates		Crest	
		From—	To—	Stage	Date
MISSISSIPPI SYSTEM—continued					
Ohio Basin—Continued					
Dam No. 41, Louisville, Ky.:	Feet	Mar. 19	Mar. 29	39.1	Mar. 23.
Upper gage.....		28	May 15	May 20	30.1
Low-water gage.....	51	Mar. 19	Mar. 29	62.0	Mar. 24.
		May 16	May 20	53.1	May 17.
Dam No. 43.....	55	Mar. 19	Mar. 29	64.5	Mar. 24.
Dam No. 44, Leavenworth, Ind.....	50	May 17	May 18	55.6	May 17.
		Mar. 19	Mar. 30	63.0	Mar. 24.
Dam No. 45, Addison, Ky.....	45	May 15	May 22	54.8	May 17-18.
		Mar. 20	Mar. 31	54.2	Mar. 25.
Dam No. 46, Owensboro, Ky.....	39	May 16	May 22	48.0	May 18.
		Mar. 21	Apr. 1	44.0	Mar. 25-26.
Dam No. 47, Newburgh, Ind.....	35	May 17	May 23	40.2	May 19.
		Mar. 20	Apr. 4	45.0	Mar. 26-27.
Evansville, Ind.....	35	Apr. 19	Apr. 26	39.4	Apr. 22.
		May 15	May 26	41.9	May 20.
Dam No. 48, Cypress, Ind.....	35	Mar. 19	Apr. 5	45.2	Mar. 26-27.
		Apr. 19	Apr. 26	39.6	Apr. 22.
Mount Vernon, Ind.....	35	May 15	May 26	42.3	May 20.
		Mar. 20	Apr. 6	45.2	Mar. 28.
Dam No. 49.....	35	Apr. 20	Apr. 26	38.5	Apr. 23.
		May 16	May 26	41.9	May 21.
Shawneetown, Ill.....	35	Mar. 20	Apr. 7	46.1	Mar. 29.
		Apr. 19	Apr. 27	38.7	Apr. 23.
Dam No. 50, Fords Ferry, Ky.....	32	May 16	May 29	43.4	May 23.
		Mar. 21	Apr. 9	47.3	Mar. 31-Apr. 1.
Dam No. 51, Golconda, Ill.....	38	Apr. 20	Apr. 28	38.3	Apr. 24.
		May 16	May 30	45.2	May 24.
Paducah, Ky.....	43	Mar. 21	Apr. 11	49.9	Mar. 31-Apr. 1.
		Apr. 18	Apr. 29	40.0	Apr. 24-25.
Dam No. 52, Brookport, Ill.....	35	May 16	May 30	47.5	May 24.
		Mar. 20	Apr. 30	50.7	Apr. 1.
Dam No. 53, Grand Chain, Ill.....	38	May 14	June 1	48.1	May 24.
		Mar. 24	Apr. 8	46.3	Mar. 31.
Cairo, Ill.....	45	May 18	May 29	43.6	May 24.
		Mar. 26	Apr. 8	47.3	Apr. 3.
White Basin	45	May 20	May 27	43.7	May 24.
		Mar. 22	Apr. 29	47.3	Apr. 3.
Black:	11	May 14	June 2	44.0	May 24.
		Mar. 22	Apr. 30	50.4	Apr. 4.
Leeper, Mo.....	14	May 13	June 4	48.8	May 21-23.
		Mar. 26	Apr. 13	51.9	Apr. 4.
Poplar Bluff, Mo.....	14	Apr. 21	Apr. 24	45.2	Apr. 23.
		May 15	June 5	51.8	May 21-22.
Black Rock, Ark.....	14	Apr. 16	June 3	23.1	May 22.
		May 16	May 18	29.4	May 16.
Cotter, Ark.....	21	May 15	May 19	36.4	Do.
		do.....	May 20	36.4	May 17.
Calico Rock, Ark.....	18	May 17	May 23	32.1	May 19.
		Apr. 23	June 6	28.4	May 23.
Batesville, Ark.....	23	May 21	June 3	26.9	May 25.
		May 24	June 2	31.0	May 28.
Newport, Ark.....	26	May 16	May 18	26.4	May 16.
		do.....	May 19	27.7	May 17.
Georgetown, Ark.....	21	May 17	do.....	23.7	May 18.
		May 16	May 20	25.1	Do.
De Valls Bluff, Ark.....	24	do.....	May 21	23.9	May 19.
		May 19	do.....	25.8	May 20.
Clarendon, Ark.....	30	Mar. 7	Mar. 13	30.4	Mar. 11-12.
		Apr. 1	June 17	39.4	May 31.
Arkansas Basin					
Neosho:					
Parsons, Kans.....	22	May 13	May 13	23.7	May 13.
Oswego, Kans.....	17	do.....	May 14	22.1	Do.
Fort Gibson, Okla.....	22	May 15	May 17	25.5	May 16.
North Canadian:					
Woodward, Okla.....	6	May 7	May 7	7.0	May 7.
Canton, Okla.....	6	May 8	May 8	6.4	May 8.
		Apr. 2	Apr. 2	20.0	Apr. 2.
Petit John: Danville, Ark.....	20	Apr. 22	Apr. 23	20.8	Apr. 22.
		Apr. 28	Apr. 28	20.2	Apr. 28.
Arkansas:	23	May 16	May 19	23.6	May 17.
		May 15	May 18	26.4	May 16.
Webbers Falls, Okla.....	22	do.....	May 19	27.7	May 17.
		May 17	do.....	23.7	May 18.
Fort Smith, Ark.....	22	May 16	May 20	25.1	Do.
		do.....	May 21	23.9	May 19.
Ozark, Ark.....	20	do.....	do.....	25.8	May 20.
		May 19	do.....	30.4	Mar. 11-12.
Dardanelle, Ark.....	25	Mar. 7	Mar. 13	30.4	Mar. 11-12.
		Apr. 1	June 17	39.4	May 31.
Morrilton, Ark.....	29	Apr. 1	June 17	39.4	May 31.
		Feb. 28	Mar. 3	24.4	Mar. 1.
Pine Bluff, Ark.....	25	Mar. 6	Mar. 10	25.2	Mar. 7.
		Mar. 31	Mar. 31	20.1	Mar. 31.
Yancopin, Ark.....	20	Apr. 27	Apr. 27	21.8	Apr. 27.
		May 16	May 19	24.7	May 16.
Sulphur:	20	May 26	May 29	23.8	May 26.
		Mar. 4	Mar. 16	25.8	Mar. 11.
Ringo Crossing, Tex.....	22	May 1	May 6	23.5	May 3-4.
		May 21	May 26	24.4	May 22.
Naples, Tex.....	22	June 1	June 5	23.4	June 2-3.

Table of flood stages March to June, inclusive, 1933—Continued

Table of flood stages March to June, inclusive, 1933—Continued

River and station	Flood stage	Above flood stages—dates		Crest	
		From—	To—	Stage	Date
MISSISSIPPI SYSTEM—continued					
Lower Mississippi Basin					
St. Francis:	Feet	Apr. 16	Apr. 19	35.3	Apr. 17.
Chaonia, Mo.....	22	May 3	May 3	24.7	May 3.
		May 12	May 18	38.0	May 15.
		Apr. 16	Apr. 22	28.5	Apr. 17-18.
Fisk, Mo.....	20	May 2	May 10	23.5	May 4.
		May 12	May 21	26.9	May 15-16.
St. Francis, Ark.....	18	Apr. 15	Apr. 28	25.0	Apr. 21.
		May 5	May 28	27.1	May 18.
Madison, Ark.....	32	Apr. 15	Apr. 15	32.3	Apr. 15.
Tallahatchie: Swan Lake, Miss.....	24	Dec. 16	June 9	33.4	Apr. 8.
Yazoo:					
Greenwood, Miss.....	36	Mar. 29	Apr. 27	38.2	Apr. 14-17.
Yazoo City, Miss.....	25	Feb. 8	June 18	31.2	May 6-7.
Ouachita: Arkadelphia, Ark.....	12	May 16	May 16	12.0	May 16.
Black: Jonesville, La.....	50	May 9	May 14	50.1	May 11-13.
Mississippi:					
New Madrid, Mo.....	34	Mar. 26	Apr. 30	40.8	Apr. 6.
		May 15	June 5	40.7	May 22-24.
		Apr. 3	Apr. 20	39.0	Apr. 11.
Memphis, Tenn.....	35	May 22	June 7	38.7	May 29.
		Mar. 31	May 7	50.5	Apr. 13.
Helena, Ark.....	41	May 19	June 12	50.6	June 2-3.
				51.8	Apr. 17-19.
Arkansas City, Ark.....	42	Apr. 3	June 17	53.6	June 4-6.
				44.7	Apr. 18-20.
Greenville, Miss.....	36	Apr. 5	June 19	47.2	June 6-7.
				48.1	Apr. 22.
Vicksburg, Miss.....	45	Apr. 14	May 14	48.8	June 10.
		May 27	June 18	49.6	May 2-3.
Natchez, Miss.....	46	Apr. 17	May 19	49.6	June 12.
		May 26	June 21	50.4	May 5.
Angola, La.....	45	Apr. 21	May 20	47.6	June 12-14.
		May 29	June 21	48.0	May 4-5.
Baton Rouge, La.....	35	Apr. 20	June 23	38.5	June 15.
				29.8	May 5.
Donaldsonville, La.....	28	Apr. 22	May 19	30.1	June 14.
		June 2	June 22	23.0	May 5.
Reserve, La.....	22	Apr. 25	May 17	23.1	June 14-16.
		June 6	June 20	17.4	May 4.
New Orleans, La.....	17	May 2	June 12	17.4	June 15-16.
		June 10	June 19		
Atchafalaya Basin					
Atchafalaya:					
Simmesport, La.....	41	May 6	May 14	41.2	May 9-12.
		June 12	June 14	41.0	June 12-14.

River and station	Flood stage	Above flood stages—dates		Crest	
		From—	To—	Stage	Date
MISSISSIPPI SYSTEM—continued					
Atchafalaya Basin—Continued					
Atchafalaya—Continued					
Melville, La.....	Feet 37	{ Apr. 25 May 31	May 21 June 21	38.3 38.4	May 6-11. June 13-14.
Atchafalaya, La.....	22	Jan. 10	June 29	24.1	{ May 8-16. June 10-13.
WEST GULF OF MEXICO DRAINAGE					
Trinity:					
Dallas, Tex.....	28	{ Mar. 6 Apr. 26 May 16 May 26	Mar. 8 Apr. 26 May 17 May 28	34.0 28.7 32.0 32.2	Mar. 7. Apr. 26. May 16. May 26.
Trinidad, Tex.....	28	{ Mar. 10 Apr. 29 May 29	Mar. 17 May 1 June 7	34.3 29.1 32.3	Mar. 14. Apr. 30. June 4.
Liberty, Tex.....	25	Mar. 8	Mar. 13	26.0	Mar. 10-11.
GULF OF CALIFORNIA DRAINAGE					
Eagle: Eagle, Colo.....	5	{ June 1 June 4 June 10	June 2 June 8 June 18	5.5 6.0 6.8	June 2. June 7. June 12.
Roaring Fork: Carbondale, Colo.....	5	{ May 31 June 10 June 10	June 7 June 21 June 21	6.1 6.4 6.1	June 2. June 12. June 12.
North Fork: Paonia, Colo.....	9	May 31	May 31	9.2	May 31.
Gunnison: Delta, Colo.....	9	May 27 June 12	June 7 June 13	10.5 9.2	June 2. June 12.
Colorado:					
Grand Junction, Colo.....	11	{ June 3 June 13	June 3 June 13	11.5 11.0	June 3. June 13.
Parker, Ariz.....	7	May 28	June 30	11.4	June 19, 20, 22, 23.
PACIFIC SLOPE DRAINAGE					
Columbia Basin					
Kootenai: Bonners Ferry, Idaho.....	31	June 18	June 21	32.0	June 19.
Clark Fork: Newport, Wash.....	22	June 15	June 29	24.8	June 21-23.
Clearwater: Kamiah, Idaho.....	12	May 30	June 19	16.6	June 10.
Santiam: Jefferson, Oreg.....	10	June 9	June 9	12.0	June 9.
Willamette: Portland, Oreg.....	24	June 11	June 22	24.8	June 13.
Columbia:					
Marcus, Wash.....	24	May 14	(¹)	38.7	June 22, 23.
The Dalles, Oreg.....	40	June 18	June 20	40.5	June 19.
Vancouver, Wash.....	15	May 28	(¹)	25.5	June 19.

¹ Continued into July.

HISTORY OF THE APPLICATION OF METEOROLOGY TO AERONAUTICS WITH SPECIAL REFERENCE TO THE UNITED STATES¹

By WILLIS RAY GREGG

INTRODUCTION

Aeronautics, as an industry, is less than 30 years old. Thus, it has come into being and developed to its present stature many years after the organization of national weather services. In this respect it is unique among the major industries.

Roughly speaking the world began to regard weather seriously about three quarters of a century ago. At that time agriculture, commerce, and marine navigation had been "going concerns" for centuries. True, in more recent years they have undergone marvelous development and change, but basically they were much the same then as now. It was necessary, therefore, that meteorological service be organized to meet the needs of these industries as they existed. With the changes in all lines of industry that have since occurred it has, of course been necessary for meteorological service to adapt itself to these changes. The same factor that has played a major role in revolutionizing industry, namely, the marvelous development in the speed of communications, is likewise largely responsible for the changes that have taken place in weather service. Speed in assembling the data

and promptness in making them and the forecasts based on them available for use are the all-essential features in providing service to all classes of industry. Fortunately, when aeronautics appeared on the scene, demanding its share of service, the proper tools were at hand. It was only necessary to sharpen some of them, reshape others, and put them all to work.

MAN'S DESIRE TO FLY

Although aeronautics as an industry is not yet 30 years old, it is through no lack of desire on the part of man to fly that it was so late in arriving. From the earliest recorded times man has not only desired but in many cases has tried to fly. As early as the fourth century B.C., according to Aulus Gellius, a model was made of wood, in the form of a bird, and was to be flown by regulated mechanics. Thus, the first attempt of which we have a record was with a heavier-than-air device.

It is quite certain that an ascent was made in a hot-air balloon during the reign of the Emperor Nero, and perhaps the tragic ending of that flight marked the beginning of a much-too-long list of what we now call "aircraft accidents." That these were not merely isolated attempts of crack-brained enthusiasts is evident from a reading

¹ Read before the meeting of the American Meteorological Society, June 20, 1933, in connection with the Century of Progress Exposition, Chicago, Ill.